

Helena and Ascension, must each give rise to sounds that pass through 50 miles or so of water, producing interference maxima and minima as in thunder, and then emerge here and there from the gentle swells of the ocean. Thus a simple natural explanation is found for what has long been a puzzle to science and a mystery to the credulous.—[C. A.]

OCEANIC NOISES; UMINARI.¹

By T. TERADA.

Oceanic noises, called "uminari" in Japanese, are common phenomena among the littoral of Japan.

On account of their intimate connection with the cyclonic centers, the sounds are observed and recorded at the meteorological stations and are reported to the central observatory in the daily weather telegrams. The oceanic noises resemble the rumbling of a heavy wagon passing over an uneven road or crossing a bridge. They are more distinctly audible at a distance of a few miles from the coast, rather than on the coast itself.

Undoubtedly the oceanic noises are produced by the breakers dashing on the coast, but how the breaking waves produce them is not fully understood. When waves break upon the shore they produce not only aerial vibrations, but also tremors in the ground, which are propagated to some distance; it seems uncertain, however, that these sounds, which are of such relatively short periods, are propagated through the porous ground to considerable distances. The aerial vibrations produced by the tremors of the ground are very small; the noises produced by the air escaping from the breaking waves would have a pretty large amplitude, although they would be somewhat irregular in period. On the shore these noises are confounded with a great variety of other noises, such as the rustling of beach pebbles, the dashing sounds of the water, etc. At a distance from the coast these other noises, having high frequencies, die out, and the oceanic noises, having comparatively long periods, survive.

There are many causes of the comparatively large limit of audibility of the oceanic noises. It is a noteworthy fact that in the case of oceanic noises the source of the sounds is not a single point, but is a line source distributed along the long shore line. In the case of a point source the intensity of the sound decreases in an inverse proportion to the square of the distance from the source. But in the case of multiple sources located along a straight line the case is somewhat different. When the sources produce sound waves of like phase, the resultant wave is cylindrical, and the intensity of the sounds is in simple inverse proportion to the distance. In the case of oceanic noises the sources may be supposed to lie in a straight line, but the waves from the different sources are in differing phases. In this case the intensity of the sound is decreased inversely proportional to the distance. If this simple consideration is approximately correct, the difference between the propagations of the sounds of cannonading and of oceanic noises would be readily explained. The intensity of the sounds from cannonading is reduced to one-hundredth at a distance of 10 fold, but that of the oceanic noises is reduced to only one-tenth at the same distance.

As a matter of fact, the cause of oceanic noises may not be such a simple one as that described above. Such a simple law may hold to some extent within a radius of a few hundred meters, but when the distance increases to several kilometers or more it is necessary to consider the influence of the distribution of winds and temperatures in the higher atmospheric strata. Here the study of oceanic sounds enters the realm of aerology.

Dr. Terada urges those who have the opportunity to measure the intensity of the oceanic sounds by the "Verdeckungsmethode," and to determine the frequencies by using Helmholtzian resonators, as he did during April, 1915, along the shore at Odawara, on the southwest coast of Honshu, Japan.

CIRRUS BANDS AND THE AURORA.

By DOUGLAS F. MANNING.

[Dated: Alexandria Bay, N. Y., Aug. 3, 1915.]

A condition worthy of noting was observed here Sunday, August 1; in fact, I have seen a similar condition on various occasions, but not so pronounced, showing either a coincidence or connection between the aurora and the cirrus clouds.

On the day mentioned, toward 11 a. m., a belt of cirro-stratus clouds formed in the northern sky about 30° above the horizon, beneath which the sky remained clear. This arch of cloud became quite well defined during the afternoon. Above, long cirrus streamers or mares' tails arose, having their base in the belt of cirro-stratus; in fact the cirrus clouds were taking every appearance of a display of the aurora, the clear space beneath the arch being especially marked. This state of affairs maintained with little change throughout the day, and when darkness came on imagine my surprise in seeing the sky lit up with the aurora, arranged, especially in regard to the arch, almost identical as that of the cirrus clouds. The display, however, did not last long, nor was it but a faint glow, but enough to make one wonder if the strange shapes of the cirrus clouds were in any way controlled by influences which cause the aurora.

[Compare similar observations reported by Birkeland and published in this REVIEW, April, 1914, 42: 211.—C. A., jr.]

EDDY MOTION IN THE ATMOSPHERE.¹

By G. I. TAYLOR.

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It has been known for a long time that the retarding effect of the surface of the earth on the velocity of the wind must be due in some way to eddy motion, but no detailed calculations appear to have been made on the subject. The present paper deals with the effect of a system of eddies on the velocity of the wind and also on the temperature and humidity of the atmosphere. Considering first the propagation of heat in a vertical direction the ordinary conductivity of heat by molecular agitation is extremely small, but a more potent effect may be produced by vertical transference of air, which retains its heat as it passes into regions where the potential temperature differs from that of the layer from which it

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¹ See Phil. Trans. Royal Society, 1915, 215: 1-26.

started. It appears, on calculation, that potential temperature (i. e., temperature assumed by a gas when its pressure is altered adiabatically to some standard pressure, will be transmitted upward through the atmosphere by means of eddies in the same way that temperature is transmitted in a solid of conductivity K , provided that $K\rho\sigma = \frac{1}{2}\omega d$; where ρ is the density and σ , the specific heat of air, ω represents the mean vertical velocity of the air in those places where it is moving upward, and d the average vertical distance traversed by the eddies; K is termed the "eddy conductivity" of the air. Now, if the temperature distribution in the air at any time is known and the subsequent changes at the base of the atmosphere, the temperature distribution at any later time can be calculated, assuming a value for K . The theory was put to the test by means of some kite ascents made from the ice scout ship *Scotia* in the North Atlantic. From these the upper-air temperature distribution was determined; and by tracing back the course of the air over the sea the different temperatures to which the surface layer had been exposed for the preceding few days were approximately obtained. The upper-air temperature distribution was found to agree well with that which would be expected from the theory, and calculation of K for the individual ascents gave values showing some proportionality to the mean wind velocity. As the eddy motion would naturally be more pronounced on days of strong wind, this result is satisfactory.

In the same manner that eddies effect a transference of heat between different parts of the atmosphere, so also will there be a transference of momentum from one air current to another. The velocity of the layer of air in immediate contact with the earth is reduced by the fric-

tional drag, and assuming this reduction of velocity to be communicated to the upper layers by "eddy viscosity," certain relations between the surface and upper wind are worked out. The resulting height-velocity and height-direction curves obtained agree remarkably well with the mean results of observations made with pilot balloons on Salisbury Plain. One noteworthy feature in which the theoretical result agrees with the experimental is that the gradient wind velocity is attained by the actual wind at a less height than that at which the gradient direction is reached. The present theory agrees with the observed facts in several particulars where the previously existing theory of Guldberg and Mohn fails.—*J. S. Dines.*

NATURE OF THE ZODIACAL LIGHT.¹

By F. SCHMID.

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The suggestion is made that the zodiacal light may be due to sunlight reflected from the lenticular segment of the earth's atmosphere produced by the equatorial protuberance due to rotation. The difficulty that the phenomenon follows very closely the axis of the ecliptic and not the Equator is explained by suggesting that the atmospheric protuberance is displaced by the gravitational action of the sun and planetary systems, all of which are nearly in the ecliptic plane. The idea is elaborated by several excellent diagrams showing the coincidences with the observed phenomena.—*C. P. Butler.*

¹ See Archives des sciences, 1915, 39:149-166, 237-240.